Gujarat Vidyapeeth, Ahmedabad

Curriculum of M.Sc Microbiology Course, Semester I,II,III,IV, Choice Based Credit System (Effective from June-2016)

CORE PAPERS

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Paper Code</th>
<th>Name of Paper</th>
<th>Semester</th>
<th>Theory</th>
<th>Practical</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Credit</td>
<td>Hours</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>MIC-101</td>
<td>Microbial Diversity</td>
<td>I</td>
<td>4</td>
<td>60</td>
</tr>
<tr>
<td>2</td>
<td>MIC-102</td>
<td>Microbial Physiology</td>
<td>I</td>
<td>4</td>
<td>60</td>
</tr>
<tr>
<td>3</td>
<td>MIC-103</td>
<td>Bio-Instrumentation</td>
<td>I</td>
<td>4</td>
<td>60</td>
</tr>
<tr>
<td>4</td>
<td>COMPL-101</td>
<td>Padyatra-1</td>
<td>I</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>COMPL-102</td>
<td>Udhyog-1</td>
<td>I</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>FC-101</td>
<td>Gandhian Thoughts</td>
<td>I</td>
<td>2</td>
<td>30</td>
</tr>
<tr>
<td>7</td>
<td>MIC-201</td>
<td>Enzymology</td>
<td>II</td>
<td>4</td>
<td>60</td>
</tr>
<tr>
<td>8</td>
<td>MIC-20</td>
<td>Molecular Biology and Microbial Genetics</td>
<td>II</td>
<td>4</td>
<td>60</td>
</tr>
<tr>
<td>9</td>
<td>MIC-203</td>
<td>Recombinant DNA Technology</td>
<td>II</td>
<td>4</td>
<td>60</td>
</tr>
<tr>
<td>10</td>
<td>COMPL-201</td>
<td>Udhyog-2</td>
<td>II</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>11</td>
<td>MIC-301</td>
<td>Bioprocess Technology</td>
<td>III</td>
<td>4</td>
<td>60</td>
</tr>
<tr>
<td>12</td>
<td>MIC-302</td>
<td>Environmental Biotechnology</td>
<td>III</td>
<td>4</td>
<td>60</td>
</tr>
<tr>
<td>13</td>
<td>MIC-303</td>
<td>Microbial Technology</td>
<td>III</td>
<td>4</td>
<td>60</td>
</tr>
<tr>
<td>14</td>
<td>COMPL-301</td>
<td>Padyatra-2</td>
<td>III</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>15</td>
<td>COMPL-302</td>
<td>Udhyog-3</td>
<td>III</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>16</td>
<td>MIC-401</td>
<td>Biostatistics and Computer Application</td>
<td>IV</td>
<td>4</td>
<td>60</td>
</tr>
<tr>
<td>17</td>
<td>MIC-402</td>
<td>Research Methodology and Scientific Writing</td>
<td>IV</td>
<td>4</td>
<td>60</td>
</tr>
<tr>
<td>18</td>
<td>MIC-403</td>
<td>Dissertation Work</td>
<td>IV</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>19</td>
<td>COMPL-401</td>
<td>Udhyog-4</td>
<td>IV</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

ELECTIVE PAPERS

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Paper Code</th>
<th>Name of Paper</th>
<th>Semester</th>
<th>Theory</th>
<th>Practical</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Credit</td>
<td>Hours</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>EC-101</td>
<td>Immunology</td>
<td>I</td>
<td>4</td>
<td>60</td>
</tr>
<tr>
<td>2</td>
<td>EC-102</td>
<td>Clinical Microbiology</td>
<td>I</td>
<td>4</td>
<td>60</td>
</tr>
<tr>
<td>3</td>
<td>EC-103</td>
<td>Forensic Microbiology</td>
<td>I</td>
<td>4</td>
<td>60</td>
</tr>
<tr>
<td>4</td>
<td>EC-201</td>
<td>Bioinformatics</td>
<td>II</td>
<td>4</td>
<td>60</td>
</tr>
<tr>
<td>5</td>
<td>EC-202</td>
<td>Nanotechnology</td>
<td>II</td>
<td>4</td>
<td>60</td>
</tr>
<tr>
<td>6</td>
<td>EC-203</td>
<td>Biostatistics</td>
<td>II</td>
<td>4</td>
<td>60</td>
</tr>
<tr>
<td>7</td>
<td>EC-301</td>
<td>Biomethanation</td>
<td>III</td>
<td>4</td>
<td>60</td>
</tr>
<tr>
<td>8</td>
<td>EC-302</td>
<td>Anaerobic Bioreactor Design</td>
<td>III</td>
<td>4</td>
<td>60</td>
</tr>
<tr>
<td>9</td>
<td>EC-303</td>
<td>Bioenergy</td>
<td>III</td>
<td>4</td>
<td>60</td>
</tr>
</tbody>
</table>

Papers Shown in Bold Letters are currently being Taught

SUMMARY

<table>
<thead>
<tr>
<th>Semester</th>
<th>Total Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semester-I</td>
<td>34</td>
</tr>
<tr>
<td>Semester-II</td>
<td>30</td>
</tr>
<tr>
<td>Semester-III</td>
<td>32</td>
</tr>
<tr>
<td>Semester-IV</td>
<td>22</td>
</tr>
<tr>
<td>Grand Total</td>
<td>118</td>
</tr>
</tbody>
</table>
### Core Papers

<table>
<thead>
<tr>
<th>No.</th>
<th>Paper Code</th>
<th>Paper Name</th>
<th>Semester</th>
<th>Theoretical</th>
<th>Practical</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MIC-101</td>
<td>Microbiology &amp; Biostatistics</td>
<td>I</td>
<td>4 50 100</td>
<td>3 60 100</td>
</tr>
<tr>
<td>2</td>
<td>MIC-102</td>
<td>Microbiology &amp; Biostatistics</td>
<td>I</td>
<td>4 50 100</td>
<td>3 60 100</td>
</tr>
<tr>
<td>3</td>
<td>MIC-103</td>
<td>Biotechnology</td>
<td>I</td>
<td>4 50 100</td>
<td>3 60 100</td>
</tr>
<tr>
<td>4</td>
<td>COMPL-101</td>
<td>Pathology-1</td>
<td>I</td>
<td>- - -</td>
<td>2 - น.65</td>
</tr>
<tr>
<td>5</td>
<td>COMPL-102</td>
<td>Pathology-1</td>
<td>I</td>
<td>- - -</td>
<td>2 - น.65</td>
</tr>
<tr>
<td>6</td>
<td>FC-101</td>
<td>General-kit</td>
<td>I</td>
<td>2 30 50</td>
<td>- -</td>
</tr>
<tr>
<td>7</td>
<td>MIC-201</td>
<td>Food Science</td>
<td>II</td>
<td>4 50 100</td>
<td>3 60 100</td>
</tr>
<tr>
<td>8</td>
<td>MIC-202</td>
<td>Microbiology</td>
<td>II</td>
<td>4 50 100</td>
<td>3 60 100</td>
</tr>
<tr>
<td>9</td>
<td>MIC-203</td>
<td>Microbiology</td>
<td>II</td>
<td>4 50 100</td>
<td>3 60 100</td>
</tr>
<tr>
<td>10</td>
<td>COMPL-201</td>
<td>Microbiology</td>
<td>II</td>
<td>- - -</td>
<td>3 - น.65</td>
</tr>
<tr>
<td>11</td>
<td>MIC-301</td>
<td>Process Technology</td>
<td>II</td>
<td>4 50 100</td>
<td>3 60 100</td>
</tr>
<tr>
<td>12</td>
<td>MIC-302</td>
<td>Process Technology</td>
<td>II</td>
<td>4 50 100</td>
<td>3 60 100</td>
</tr>
<tr>
<td>13</td>
<td>MIC-303</td>
<td>Microbiology</td>
<td>II</td>
<td>4 50 100</td>
<td>3 60 100</td>
</tr>
<tr>
<td>14</td>
<td>COMPL-301</td>
<td>Process Technology</td>
<td>II</td>
<td>- - -</td>
<td>2 - น.65</td>
</tr>
<tr>
<td>15</td>
<td>COMPL-302</td>
<td>Process Technology</td>
<td>II</td>
<td>- - -</td>
<td>2 - น.65</td>
</tr>
<tr>
<td>16</td>
<td>MIC-401</td>
<td>Microbiology</td>
<td>II</td>
<td>4 50 100</td>
<td>- -</td>
</tr>
<tr>
<td>17</td>
<td>MIC-402</td>
<td>Microbiology</td>
<td>II</td>
<td>4 50 100</td>
<td>- -</td>
</tr>
<tr>
<td>18</td>
<td>COMPL-401</td>
<td>Process Technology</td>
<td>II</td>
<td>- - -</td>
<td>2 - น.65</td>
</tr>
<tr>
<td>19</td>
<td>COMPL-402</td>
<td>Process Technology</td>
<td>II</td>
<td>- - -</td>
<td>2 - น.65</td>
</tr>
</tbody>
</table>

**Note:** น.65 = 30%
## ELECTIVE PAPERS

<table>
<thead>
<tr>
<th>Paper Code</th>
<th>Paper Name</th>
<th>Semester</th>
<th>Theory</th>
<th>Lab</th>
<th>Total</th>
<th>Practical</th>
<th>Theory</th>
<th>Lab</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>EC-101</td>
<td>Clinical Electronics</td>
<td>First</td>
<td>4</td>
<td>50</td>
<td>100</td>
<td>3</td>
<td>60</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>EC-102</td>
<td>Clinical Biochemistry</td>
<td>First</td>
<td>4</td>
<td>50</td>
<td>100</td>
<td>3</td>
<td>60</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>EC-103</td>
<td>Clinical Biochemistry</td>
<td>First</td>
<td>4</td>
<td>50</td>
<td>100</td>
<td>3</td>
<td>60</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>EC-201</td>
<td>Biochemistry</td>
<td>Third</td>
<td>4</td>
<td>50</td>
<td>100</td>
<td>3</td>
<td>60</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>EC-202</td>
<td>Biochemistry</td>
<td>Third</td>
<td>4</td>
<td>50</td>
<td>100</td>
<td>3</td>
<td>60</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>EC-203</td>
<td>Biochemistry</td>
<td>Third</td>
<td>4</td>
<td>50</td>
<td>100</td>
<td>3</td>
<td>60</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>EC-301</td>
<td>Biochemistry</td>
<td>Fourth</td>
<td>4</td>
<td>50</td>
<td>100</td>
<td>3</td>
<td>60</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>EC-302</td>
<td>Clinical Biochemistry</td>
<td>Fourth</td>
<td>4</td>
<td>50</td>
<td>100</td>
<td>3</td>
<td>60</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>EC-303</td>
<td>Biochemistry</td>
<td>Fourth</td>
<td>4</td>
<td>50</td>
<td>100</td>
<td>3</td>
<td>60</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

Papers Shown in Bold Letters are currently being Taught

## SUMMARY

<table>
<thead>
<tr>
<th>Semester</th>
<th>Total Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semester-I</td>
<td>34</td>
</tr>
<tr>
<td>Semester-II</td>
<td>30</td>
</tr>
<tr>
<td>Semester-III</td>
<td>32</td>
</tr>
<tr>
<td>Semester-IV</td>
<td>22</td>
</tr>
<tr>
<td>Total</td>
<td>98</td>
</tr>
</tbody>
</table>
Learning outcomes:-
1. Student will understand the evolution of life.
2. Student will understand the distribution of microorganisms in different ecosystems.
3. Student will understand the role of microorganisms in extreme environment and their importance.

Unit I: Microbial Evolution and Taxonomy
1. Origin of earth and life,
   Microbial evolution and biogeochemical cycles
2. Impact of oxygen, Endosymbiotic evolution, Origin of ozone layer,
   Evolutionary chronometers,
   Sequence of Major events during biological evolution
3. Taxonomy of Eubacteria and Archaea- Nomenclature, classification, Identification
4. Nomenclature, Bergey’s Manual- The nature of bacterial identification schemes,
   prokaryote or eukaryote, the four major categories of bacteria, groups within the four major categories of bacteria

Unit II: Basics of Microbial Diversity
1. Prokaryotic diversity:
   Bacteria- Purple and Green bacteria, Cyanobacteria, Prochlorophytes, Spirilla, Pseudomonads, Free-living aerobic nitrogen fixing bacteria, and Filamentous Actinomycetes
   Archaea- Diversity and physiology of methanogenic Archaea, overview of Hyperthermophilic Archaea
   Eukarya- Algae, Protozoa
2. The challenges of studying microbial diversity
3. Microbial metabolism of Hydrogen
4. Aerobic metabolism of Glucose
5. Aerobic metabolism of Methane and Methanol
6. Microbial metabolism of carbon dioxide
7. Microbial diversity loss- causes and restoration

Unit III: Extremophiles
1. Extremes of environmental conditions allowing bacterial growth and survival
2. Extremophilic microbes- acidophiles, alkaliphiles, psychrophiles, barophiles, halophiles, thermophiles,
   Taxonomy and physiology of Extremely Halophilic Archaea,
3. Microbial diversity of rumen
4. Microbial diversity of desert ecosystem
Unit- IV: Importance and Exploitation of Microbial Diversity

1. Biotechnology- why genetic engineering
2. Biotechnology of artificial cells including application to artificial organs
3. Bioactive microbial metabolites as pharmaceuticals (microbial products in perspective)
4. Marketed microbial agents with therapeutic and other utilities (antibacterials, antifungals, antineoplastics)
5. Biotechnology applied to Raw Mineral Processing, Microbially Enhanced Oil Recovery
6. Microbial diversity and biodegradation of xenobiotics
7. Exploitation of fungal and cyanobacterial diversity
8. Societal issues of biotechnology

Practical MIC 101-Microbial Diversity

1. Study of Physiological diversity of microorganisms
2. Study of Metabolic diversity of microorganisms
3. Study of fungal diversity
4. Isolation of phosphate solubilizes.
5. Isolation of Antibiotic producers.
6. Isolation of Amylase producers.
7. Isolation of yeast

References:

3. Microbiology: Diversity, Disease and the Environment, by Abigail A Salyers and Dixie D Whitt, Fitzgerald Science Press, Maryland
4. Bergey’s Manual of Determinative Bacteriology, by John G Holt, Noel R Krieg, Peter HA Sneath, James T Staley and Stanley T Williams, Lippincott Williams & Wilkins, Maryland
8 Global Biodiversity Assessment, Editor-Heywood, V.H. and Watson, R.T. Cambridge University, Press.

9 Biodiversity of Microbial Life, Editor-Staley, JT and Reysenbach, A.L, Wiley-Liss Publication, NY.

10 Molecular Biotechnology: Principles and Applications of Recombinant DNA, by Bernard R. Glick, Jack J Pasternak, Cheryl L Patten.

Learning Outcomes:-
1. Student will understand the different metabolic activity.
2. Student will understand the effect of radiation, inorganic and organic components on microbes.

Unit-1: INTRODUCTION TO MICROBIAL PHYSIOLOGY
1.1 The *Escherichia coli* Paradigm
1.2 Cell surface
1.3 Microbial genetics
1.4 Chemical Synthesis
1.5 Special Topics (Growth, Growth cycle, Continuous Culture)
1.6 Factors affecting Growth

Unit-2: MEMBRANE TRANSPORT, PHYSIOLOGICAL ADAPTATIONS AND INTERCELLULAR SIGNALING
2.1 Cytoplasmic Membrane and Transport
   2.1.1 Membrane Structure
   2.1.2 The Functions of cytoplasmic membrane
   2.1.3 Nutrient Transport
2.2 Physiological Adaptation and Intercellular signaling
   2.2.1 Overview of Regulation of gene expression
   2.2.2 DNA-Binding Proteins structures
   2.2.3 Singnal Transduction
   2.2.4 Molecular mechanisms of Singanal transduction
   2.2.5 Quorum Sensing
   2.2.6 Celluler Differentiation
   2.2.7 Microbial Stress Responses

Unit 3: PHYSIOLOGICAL AND METABOLIC DIVERSITY OF MICROORGANISMS
3.1 Metabolic Strategies for Generating Cellular Energy
3.2 Evolution and Diversity of Photosynthetic and Autotrophic Bacteria
   3.2.1 The Phototrophic way of Life (Photosynthesis, Chlorophyll and Bacteriochlorophylls, Carotenoids and Phycobilins, Anoxygenic Photosynthesis, Oxygenic Photosynthesis)

Unit-4: DIVERSITY OF HETEROTROPHIC AND AUTOTROPHIC METABOLISM
4.1 Respiration
   4.1.1 Oxidative Phosphorylation
   4.1.2 Aerobic Chemoorganotrophic Process
   4.1.3 Anaerobic Respiration
4.2 Autotrophy (The Calvin Cycle, Other Autotrophic pathways, Nitrogen Metabolism)

Practicals  (MIC-102 MICROBIAL PHYSIOLOGY)

1  Growth Kinetics: Calculation of Generation time, Growth rate, µMax  Substrate utilization (Glucose -Coles method)
2  Growth Measurement by Biomass (Fungal culture), Gravimetric Method
3  Factors affecting growth: pH, Temperature, Aeration, Agitation, Carbon source, Nitrogen source
4  Measurement of Water Activity (Aw).
5  Measurement of Death Rate of Bacteria.
6  DNA Estimation: DPA Method, UV Method-260 nm
7  RNA  Estimation: Orcinol Method.
GUJARAT VIDYAPITH, AHMEDABAD
BIOGAS RESEARCH AND DEPARTMENT OF MICROBIOLOGY
MIC 103: Bioinstrumentation (Sem-1)

Credits-4
Teaching Hrs.- 60

Learning Outcomes:-
1. Student will learn principles, working and applications of various instruments.
2. Student will understand the application of various instruments for analysis.

<table>
<thead>
<tr>
<th>Unit</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Principle, Instrumentation and Applications:</td>
</tr>
<tr>
<td></td>
<td>i. Principle and application of scanning and transmission electron microscopy, scanning tunneling microscopy, confocal microscopy.</td>
</tr>
<tr>
<td></td>
<td>ii. PCR and Sequencing Techniques.</td>
</tr>
<tr>
<td></td>
<td>iii. <strong>Biosensors</strong>: Principle and application: Introduction, applications of biosensor, generation of biosensors, glucose biosensor, and urea biosensor.</td>
</tr>
<tr>
<td>2</td>
<td>Specialized Spectroscopy: (Principle, Instrumentation and Applications)</td>
</tr>
<tr>
<td></td>
<td>i. Infrared Spectroscopy, Flame emission Spectroscopy and Atomic absorption spectroscopy.</td>
</tr>
<tr>
<td>3</td>
<td>Separation Techniques :1: (Principle, Instrumentation and Applications)</td>
</tr>
<tr>
<td></td>
<td>i. <strong>Chromatography</strong>: Paper; TLC; Conventional Column Chromatography-Ion- Exchange; Affinity; Adsorption.</td>
</tr>
<tr>
<td></td>
<td>ii. <strong>Specialized Technique-I</strong>: GLC- Column; Detectors. HPLC: Pumps; Columns; Instrumentation.</td>
</tr>
<tr>
<td></td>
<td>iii. <strong>Specialized Technique-II</strong>: HPTLC, FPLC</td>
</tr>
<tr>
<td>4</td>
<td>Separation Techniques: 2: (Principle, Instrumentation and Applications)</td>
</tr>
<tr>
<td></td>
<td>i. <strong>Centrifugation Techniques</strong>: Types of centrifugation; Rate Zone; Isopycnic; High speed; Ultra; preparative; Gradient.</td>
</tr>
<tr>
<td></td>
<td>ii. <strong>Electrophoretic Techniques</strong>: Native, SDS, Agarose and 2D; Zone EP; Isoelectric; Slab Gel; DISC EP; Immuno EP; Pulsed Field; Cellular Gel EP.</td>
</tr>
</tbody>
</table>
References:
1 Instrumental methods of chemical analysis. *Sharma B.K.*
2 Instrumental methods of analysis. *Skoog D.A.*
5 Modern experimental Biology. *Boyer.*
14 Biosensors: An Introduction, Brain Eggins, Wiley Teuniee
MIC 103: Bioinstrumentation (Practicals)
Total Number of Hours: 60
Total Number of Credit: 02
Study of UV absorption spectra of macromolecules (protein, nucleic acid, bacterial pigments

1. Estimation of Carbohydrates by Anthrone’s Method.
2. Estimation of Reducing Sugars by DNSA Method.
3. Estimation of Carbohydrate by Nelson Somogyi’s Method
4. Estimation of Protein by Folin Lowry’s Method.
5. Determination of Compounds by Chromatography: Paper, TLC Separation of bacterial lipids/amino acids/sugars/organic acids by TLC or Paper Chromatography, ETC.
6. Analysis of Elements by Flame Photometer
7. Separation of serum protein by horizontal submerged gel electrophoresis.
8. Quantitative estimation of hydrocarbons/pesticides/organic
9. Demonstration of HPLC, HPTLC and AAS.
10. Demonstration of Fermenters
11. Separation of biomolecules by gel filtration
12. Demonstration on glucose Biosensors.
Learning outcomes:
1. Student will study Gandhian thoughts in detail.
2. Students will be enlightened about the way of life Gandhi followed.

1.1 વ્રત બેટેલે શુંઅધિકારકતા બ્રટની?
1.2 એકાદશ વ્રત
વશૂલ વ્રત અપા ક પ્રબલ અસ્ત્ર, સાથે, સાથે, સયમ: વિશ્રવાળ પરિસ્થિતિ પ્રમાણે ઉમેરા વ્રત, અનુભાવ: નિયમ સદ્ધાનતામાં સભ્યતા, અભિવાદના અર્થ, અભિશાપ, આદિપરંપત, સચેષી
1.3 જયનમાં વ્રતનું મહત્વ

2.1 રચનાદ્યક કાર્યકામ શું?
2.2 રચનાદ્યક કાર્યકામની પ્રશ્નતા?
2.3 પાઠી:
ખાટીની છિત્રાનું \ારાતય્ય અને અંચાર વરણની પરિચય,\ારાંતું મહત્વ, અગાથિય પ્રગટની અને ગૌરિય, સ્તય શ્રમનગ,\ામોદધાર માટે ખાટી(અરોગ્ય અને ખાટી, પદ્યદૃષ્ટા અને ખાટી,\2.4 વ્યાસમહૂક્તિ
વ્યાસ બેટેલે શું પર અરોગ્ય વ્યાસની, પ્રકાર વ્યાસના?
અસરભાવ્ય સામાજિક વ્યાસનની,
વ્યાસ મુખતિતના કાર્યકામો

3. આચાર્યની કેનવલી  

4 કલાક
3.1 આયારની ડેલવરી અને તેનું મહત્વ
3.2 કુટીઓમાં સમૂહાર્થની આયાર
3.3 રીશદિક સંસ્થાઓમાં સમૂહાર્થની આયાર
3.4 જહેર સંયોજનના રમસવચકતા અને રમાબ-
3.5 સામાન્ય વિવેક

અંક 4 ઉંભોનું અંશ તેનું મહત્વ:
4.1 ઉંભો વેષ્ટે શું?
4.2 ઉંભો ના સ્વપ્ર, ઉંભો રસાવયિક, ઉંભો ઉષ્મા, ઉંભો યાંટક :
   ગૃહ-વાર્તાકષેલી ઉંભોની વિસ્તપત, ઉંભો સૌર, ઉંભો નામશ૑,
4.3 ઉંભો ના સોલ્સસોલ ઉંભો પુનઃઅપાપવ અને ના-પુનઃપાપવ:
4.4 ઉંભો વયંત અને ગાંધીવિદ્યાર
4.5 બીનપરવરત ઉંભોના સાહનો સોલ્સ, હીટર સોલ્સ, સ્થળકુંઠ:
   ડીમાર, બાયોગોસ, સ્ટેલાઈટ, તલાખ સૌર, પવનયાડી,
   બાયોમાસ વગેરે
4.6 ઉંભો સંરક્ષા

References:

1. સમૂહ જીવનની આયારમંત્ર પનલાય, 
2. આરોગ્યની યાદીગામી,
3. ભારત શા માટેગાંધી?
4. સમયની તકણીપૂનઃપાપવ: ઉંભો વિકાર, જેસ, આવૃતી પાંચમી,
5. મંગળપુત્તા ગાંધીજી -
6. રૂમનામ્હ કાર્યક્રમો આજેના સંદર્ભમાં સહજીકાર -
7. રૂમનામ્હ કાર્યક્રમો- રસાના અને રહસ્ય તેનું : ગાંધીજી
8. પર્યાવરણ સાધી, સાવધાની રમણ-CEE
9. ગાંધીજીના પાવન પ્રસંગેથી સારી મધ્ય લાલુલાય -
<table>
<thead>
<tr>
<th>અંક</th>
<th>વિષય તજમલનં નામ</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>શ્રી તેજશાસ્ર કાશર</td>
</tr>
<tr>
<td>2</td>
<td>ડોપટેલ હીરાલાંઠ</td>
</tr>
<tr>
<td>3</td>
<td>શ્રી ક્લિપલાંઠ દેશાલાંઠ</td>
</tr>
<tr>
<td>4</td>
<td>ડોપટેલ .ાર ક્લિક .</td>
</tr>
<tr>
<td>5</td>
<td>ડેલાં નિશિલ .</td>
</tr>
</tbody>
</table>
GUJARAT VIDYAPITH, AHMEDABAD
BIOGAS RESEARCH AND DEPARTMENT OF MICROBIOLOGY
EC-101: IMMUNOLOGY

Credits-4  
Teaching Hrs.- 60

Learning outcomes:-
1. Student will learn about basic concepts of immunology.
2. Students will learn in detail about Antigens and Antibodies.
3. Students will understand the application of immunology.

Unit  
Topics
1  A) General principles of immunology: History of immunology: structure, composition and function of cells and organs involved in immune system. Immune response (humoral and cell mediated) innate immunity, acquired immunity; blood groups, blood transfusion and Rh-incompatibility
   B) Antigens – antibodies: Antigens-structure and properties; types-iso and allo; haptens adjuvants, antigen specificity. Membrane receptors for antigens; immunoglobulins; structure-heterogeneity-types and subtypes-properties; theories of antibody production.
2  A) Antigen and antibody interactions: In vitro methods-agglutination, precipitation, complement fixation, immunofluorescence, ELISA, radio immunoassay; in vivo methods; phagocytosis, opsonization, neutralization.
   B) Complement system; complement components. complement activation -pathways,regulation of complement system, biological consequences of complement activation, complement deficiencies.
3  A) Immunogenetics: Structure, distribution and functions of histocompatibility antigens.Major histocompatibility gene complex (MHC) and the HLI-A system; gene regulation and immune response (IR) genes; HL-A and tissue transplantation-tissue typing methods for organ and tissue transplantations in humans; graft versus host reaction and rejection.
   B) Tumor immunology: Tumor immunology - tumor antigens, Host immune response to tumors, antibody dependent cell cytotoxicity (ADCC), tumor escape mechanisms Immuno diagnosis and therapy.
   B) Immuno biotechnology: Active and passive immunization, Isolation of spleen cells, Myeloma cell lines used as fusion partner, fusion method, detection and application of monoclonal antibodies, recombinant antibodies, immunotoxins types of vaccines, whole - organism vaccines, recombinant vector vaccines, DNA vaccines, synthetic peptide vaccines, subunit vaccines, immunization procedures, adverse
reactions to vaccines.

References:

5. Cellular and Molecular Immunology. 3rd Edition by Abbas.

Practicals:

1. Ouchterlony double diffusion (Ab titration)
2. Ouchterlony double diffusion (Antigen – Antibody titration)
3. DOT ELISA
4. Single radial Immuno diffusion
5. Rocket immune electrophoresis
6. RA test
7. Immuno electrophoresis
8. Quantitative precipitin assay
9. Antibody labelling
GUJARAT VIDYAPITH, AHMEDABAD
BIOGAS RESEARCH AND DEPARTMENT OF MICROBIOLOGY
MIC- 201 Enzymology

Credits- 4  
Teaching Hrs.- 60

Learning outcomes:-
1. Students will learn about kinetics of enzyme action.
2. Students will learn about practical aspects of application of enzymes.
3. Students will learn about catalytic action of enzymes in detail.

Unit- 1: Structure and Functions of Enzymes
1 Introduction to Enzymes (History, naming and classification of Enzymes)
2 Sources of enzymes
3 Specificity of Enzyme action- Active site of enzymes, The Fischer’s ‘Lock and Key’ hypothesis, The Koshland ‘Induced fit’ hypothesis, and Hypothesis involving strain or transition-state stabilization

Unit- 2: Enzyme Kinetics
1 Kinetics of Single-substrate-enzyme catalysed reactions-
The relationship between initial velocity and substrate concentration- Derivation and significance of the ‘Henri and Michaelis-Menten’ equation; The ‘Briggs-Haldane’ modification of the ‘Michaelis-Menten’ equation; Derivation of the ‘Line Weaver-Berk’ equation and plots; The ‘Eadie-Hofstee’ and ‘Hanes’ plots; The ‘Eisenthal and Cornish-Bowden’ plots; Derivation of the ‘Haldane’ relationship for reversible reactions.
Rapid-Reaction kinetics: Pre-steady state kinetics & Relaxation kinetics
The King and Altman procedure
2 Kinetics of Multi-substrate-enzyme catalysed reactions-
Examples of possible mechanisms- Introductory knowledge of Ping-Pong bi-bi mechanism; Random-order mechanism; and Compulsory-order mechanism
Steady-state kinetics- ‘General Rate Equation’ of Alberty and Dalziel and their Rate constants
Investigation of Reaction Mechanisms using Steady-state methods: The use of Primary plots; and the use of inhibitors which compete with substrate for binding sites
Investigation of Reaction mechanisms using non-steady-state methods: Isotope exchange at equilibrium and Rapid-reaction studies
3 Sigmoidal Kinetics and Allosteric Enzymes- The ‘Monod-Wyman-Changeux (MWC) Model;
The ‘Koshland-Nemethy-Filmer (KNF) Model;
Differentiation between models for cooperative binding in proteins;
Sigmoidal kinetics in the absence of cooperative binding
4 Significance of Sigmoidal Behavior- Allosteric enzymes and Metabolic regulation

Unit- 3: Mechanisms of Enzyme-catalysed Reactions
1 Enzyme Inhibition-
Reversible inhibition -
Competitive Inhibition - Characteristics of competitive inhibition, Michaelis-Menten and Lineweaver-Burk plot showing the effect of a competitive inhibitor, Steady-state Kinetics of a single-substrate single-binding-site single-intermediate enzyme-catalysed reaction in the presence of a Competitive inhibitor
Uncompetitive inhibition - Characteristics of Uncompetitive inhibition, Lineweaver-Burk plot showing the effect of a uncompetitive inhibitor, Steady-state Kinetics of a single-substrate single-binding-site single-intermediate enzyme-catalysed reaction in the presence of a uncompetitive inhibitor
Non-competitive inhibition- Characteristics of non-competitive inhibition, Lineweaver-Burk plot showing the effect of a non-competitive inhibitor, Steady-state Kinetics of a single-substrate single-binding-site single-intermediate enzyme-catalysed reaction in the presence of a non-competitive inhibitor
Mixed inhibition - Characteristics of mixed inhibition, Lineweaver-Burk plot showing the effect of a mixed inhibitor, Steady-state Kinetics of a single-substrate single-binding-site single-intermediate enzyme-catalysed reaction in the presence of a mixed inhibitor
Partial inhibition
Substrate inhibition and Michaelis-Menten and Lineweaver-Burk plots showing the effects of substrate inhibition
Allosteric inhibition

Irreversible inhibition

2 Study of active site structure:
Binding sites and catalytic sites- enzyme-substrate complex, substrate analogues, Enzyme modification by chemical procedure affecting amino acid side chains, by treatment with proteases, by site-directed mutagenesis, Effect of changing pH

3 Chemical nature of enzyme catalysis:
Metal activated enzymes and metalloenzymes: Definitions of metal-activated enzymes and metalloenzymes, Activation by alkali metal cations (Na⁺ and K⁺), Activation by alkaline earth metal cations (Ca²⁺ and Mg²⁺), Activation by transition metal cations (Cu, Zn, Mo, Fe and Co cations)
Coenzymes in enzyme-catalysed reactions: Nicotinamide nucleotides (NAD⁺ and NADP⁺), Flavin nucleotides (FMN and FAD), Adenosine phosphates (ATP, ADP and AMP), Coenzyme A (CoA.SH), Thiamine pyrophosphate (TPP), Pyridoxal phosphate, Biotin, Tetrahydrofolate, Coenzyme B₁₂

4 Protein-ligand binding and cooperativity:
General considerations of binding of a ligand to a protein having a single ligand-binding site
Types of cooperativity,
Positive homotropic cooperativity and derivation of the ‘Hill’ equation,
The Adair equation for the binding of a ligand to a protein having two binding sites for that ligand- General considerations, under no interaction between the binding sites, under positive homotropic cooperativity; under negative homotropic cooperativity.
The Adair equation for the binding of a ligand to a protein having three and four binding sites for that ligand
Study of cooperative effects
Binding of oxygen to hemoglobin

**Unit- 4: Application of Enzymes**

1. Immobilization Techniques for Enzymes and Cell:
   - adsorption, covalent binding, cross linking, entrapment, encapsulation
   - Properties of immobilized enzymes compared to free enzymes: Change in stability, pH, apparent Km
   - General applications of immobilized enzymes

2. Handling of enzymes and coenzymes to maintain their activity

3. As Analytical Reagents:
   - Advantages and disadvantages of using enzymes as analytical reagents
   - Principles of enzymatic analysis: End-point methods, Kinetic methods and Immunoassay methods
   - In Industry: Medical applications and Industrial applications

**References:**


2. Immobilized Enzymes and Cells- Rosevear, Kennedy, J and cabral, MS, Adam Hilger, Bristol and Philadelphia


**Practical:**

1. Immobilization of enzymes
2. Determination of Ks and Km effect
3. Determination of inhibition effect on enzyme kinetics
4. Determination of Acid-Phosphatase activity.
5. Determination of Alkaline-Phosphatase activity.
6. Determination of Urease activity by ammonium-N release method
7. Determination of Urease activity by urea remaining method.
GUJARAT VIDYAPITH, AHMEDABAD  
BIOGAS RESEARCH AND DEPARTMENT OF MICROBIOLOGY  
MIC202: Molecular Biology and Microbial Genetics  

Credits-4  
Teaching Hrs.- 60

Learning outcomes- 
1. Students will able to learn molecular biology and genetics of microorganisms. 
2. Students will learn about various methods of gene transfer.

<table>
<thead>
<tr>
<th>Unit</th>
<th>Topics</th>
</tr>
</thead>
</table>
| 1    | **(A)** Structure and organization of bacterial genome and Replication:  
I. Structure of DNA- DNA is usually a double helix, Complementarities of two chains, 
Tautonomic forms of each base, DNA denatures as well as renatures, viruses have 1S (single stranded) DNA chromosomes, 1S (single stranded) DNA has compact structure  
II. Crystallographic proof of double helix in DNA Alternative forms of right-handed DNA, ‘Z’ form of DNA Methylation of ‘C’ and ‘A’ in DNA and its effects on the forms of DNA, Spontaneous deformation of double helix in solution Sequence specific bending and Kinking of DNA  
III. Bacterial DNA replication  
**(B)** Transcription and translation of bacterial genes:  
I. The structure and function of RNA- types of RNA, RNA precursors, RNA structure, RNA processing and modification  
II. Transcription- Molecular mechanism; Bacterial RNA polymerase, Transcription Initiation, Polymerization reaction, Transcription Termination  
III. Translation- Protein structure, Ribosome structure, the Genetic code, Translation initiation, elongation and termination, Polycistronic mRNA  
IV. Post translational modification and Protein folding- Mechanism of post translational modification of protein, Protein folding mechanism- Chaperones, Protein disulfide isomerases, Membrane proteins |
| 2    | **(A)** Mutations and DNA repair:  
I. Phenotypic classes of mutants, genotypic classes of mutants, conditionally lethal mutations, Silent mutations and its reasons, leaky mutations, methodology for the detection and selection of Auxotrophic mutants- phenotypic lag and phenomic lag, Suppressor mutations and its types.  
II. Mutagenesis: U.V. (physical mutagenic agent), Chemical mutagen- Base Analogues (5 Bromo Uracil and 2 Amino Purine), Oxidative deaminating agents (Nitrous acid, Hydroxyl amine), alkylating agents and intercalating agents.  
**(B)** Recombination models:  
Requirements and Molecular Models of Recombination- Holiday double stranded DNA molecules, single stranded invasion model, Molecular basis for Recombination in *E.coli-chi* sites and RecBCD Nuclease, Synapse formation and RecA protein, Ruv protein |
| 3    | **(A)** Conjugation |
Mechanism of DNA transfer during Conjugation in Gram –ve bacteria- Transfer tra genes, the oriT sequence, function of plasmid primases in transfer, Mobilizable plasmids

Chromosome transfer by plasmids- Formation of Hfr strains, transfer of chromosomal DNA by integrated Plasmids, chromosome mobilization and Prime factors

Transfer systems of Gram +ve bacteria- Plasmid attracting Pheromones

(B) Transformation

- Natural Transformation
- Competence
- Uptake of DNA during Natural Transformation
- Mechanism of DNA uptake during Transformation
- Genetic evidence for single strand uptake
- Role of Natural Transformation
- Artificially induced competence- Calcium ion induction and Electroporation

(C) Transduction

- Phage λ and lysogeny
- cII gene product
- Maintenance of lysogeny
- Regulation of repressor synthesis
- Induction of λ
- Competition between lytic and lysogenic cycles
- Generalized and specialized Transduction and its consequences

4 (A) Extra chromosomal inheritance

- Nomenclature and classification of Plasmids, Plasmid structure, phenotypic traits encoded by Plasmids.
- Properties of Plasmids: Replication-theta and rolling circle mechanism; Functions of ori region- Regulation of copy number, Host range of Plasmids; Mechanisms to prevent curing of Plasmids- Resolution of multimeric Plasmids and Partitioning; Incompatibility- due to replication control and partitioning.
- Plasmids as Cloning Vectors: Desirable features of Plasmid Cloning Vectors and Broad Host range Cloning Vectors Plasmid pBR322 and Ti Plasmid

(B) TRANSPOSITON

- Structure of Transposons
- Types of bacterial Transposons- IS elements, Composite transposons, Non-composite transposons
- Assays of transposition- suicide vectors, Mating-out assay
- Molecular models for transposition- Replicative transposition, Cut and paste transposition, Relationship between replicative and cut and paste transposition and their target regulation

(C) Control

- Lac operon- Positive control, Negative control, Catabolite repression and role of CAP
• Tryptophan operon- Attenuation control

References and Further Reading:

Books:


Practicals (MIC202: Molecular Biology and Bacterial Genetics, 60 Hours; Credits:02)

1 Isolation of pigment/antibiotic/Lac mutants of S.marcescens/E.coli using chemical mutagen/physical mutagen (U.V.).
2 Isolation of drug resistant mutants of E.coli/ S.marcescens by gradient plate technique
3 Isolation of drug/biochemical mutants of E.coli by replica plating technique.
4 Determination of Mutation rate.
5 Fluctuation test.
GUJARAT VIDYAPITH, AHMEDABAD
BIOGAS RESEARCH AND DEPARTMENT OF MICROBIOLOGY
MIC-203: RECOMBINANT DNA TECHNOLOGY

Credits-4

Teaching Hrs.- 60

Learning outcomes:
1. Students will learn about extraction of genetic material from microorganisms.
2. Students will learn about cloning.

Unit

1 Elements of rDNA Technology: Core techniques and essential enzymes used in recombination: restriction endonucleases, type I, II, III, recognition sequences, properties, nomenclature, classification of type II endonucleases, their activity. DNA ligase: Properties and specificity, S1 nuclease, DNA polymerase, polynucleotide kinase, phosphatase, reverse transcriptase its activity and mode of action. Chemical synthesis of DNA. Restriction digestion, ligation and transformation.


3 Specialized cloning strategies: Expression vectors, promoter probe vectors, vectors for library construction, genomic DNA libraries, chromosome walking and jumping, cDNA libraries, short gun cloning, directed cloning, phage display. Recombinant DNA technology with reference to cloning and production interferon and insulin. Miscellaneous applications of Genetically engineered microorganisms (GEMS) / genetically modified organisms (GMO’s).

4 Molecular mapping of genome: PCR methods and Applications DNA sequencing methods, Dideoxy and Chemical method. Sequence assembly. Automated sequencing. Genetic and physical maps, physical mapping and map –based cloning, choice of mapping population, simple sequence repeat loci, southern and fluorescence in situ hybridization for genome analysis, Chromosome microdissection and microcloning. Molecular markers in genome analysis: RFLP, RAPD and AFLP analysis, molecular markers linked to disease resistance genes Application of RFLP in forensic, disease prognosis, genetic counseling, pedigree, animal trafficking and poaching: Germplasm maintenance, taxonomy and Biodiversity.
References:

10. From genes to clones by Winnaker.
11. Manipulations and expression of recombinant DNA by Robertson.

Practicals:

1. Agarose gel electrophoresis
2. Ultrapure genomic DNA spin mini preps kit from bacteria.
3. Restriction digestion
4. Separation of genomic DNA extraction from whole blood.
5. Separation of genomic DNA from plant (CTAB)
6. DNA Amplification
7. SDS PAGE
GUJARAT VIDYAPITH, AHMEDABAD
BIOGAS RESEARCH AND DEPARTMENT OF MICROBIOLOGY
EC 201: Bioinformatics (Sem-2)

Credits-4
Teaching Hrs.- 60

Learning outcomes:-
1. Students will learn to identify microorganisms based on its sequence analysis.
2. Students will become acquired about use of various softwares used for study of microorganisms.
3. Students will learn to use gene sequence data for preparation of phylogenetic tree for identification purpose.

<table>
<thead>
<tr>
<th>Unit</th>
<th>Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Introduction to Bioinformatics: Overview, Internet and bioinformatics, Applications.</td>
</tr>
<tr>
<td>2.</td>
<td>Databases: Databases in Bioinformatics, various biological databases, Protein and Nucleotide sequence Data bases. Protein sequence, structure and Classification databases.</td>
</tr>
<tr>
<td>3.</td>
<td>Sequence analysis: Pairwise alignment, local and global alignment, Scoring matrices, multiple sequence alignment, tools for sequence alignment.</td>
</tr>
<tr>
<td>2.</td>
<td>Transcriptomics: Complete transcript cataloguing and gene discovery-sequencing based approach, Microarray based technologies and computation based technologies.</td>
</tr>
<tr>
<td>3.</td>
<td>RNA secondary structure prediction</td>
</tr>
<tr>
<td>1.</td>
<td>Protein Computational Biology: Structural classification of proteins, Protein structure analysis, Structure alignment and comparison, Secondary and tertiary structure prediction and evaluation, Prediction of specialized structures, Active site prediction, Protein folding, Protein modeling and Drug design</td>
</tr>
<tr>
<td>2.</td>
<td>Proteomics: Types of proteomics, tools for proteomics-separation and</td>
</tr>
</tbody>
</table>
isolation of proteins, acquisition of protein structure information, databases and applications

3. Phylogenetic analysis: molecular basis of evolution, Phylogenetic trees & different methods for phylogenetic inference

**Reference Books:**

6. GIS For Dummies (For Dummies (Computer/Tech)) by: Michael N. DeMers
7. GIS Basics by: Stephen Wise
8. GIS for Environmental Decision-Making (Innovations in Gis) by: Andrew A. Lovett, Katy Appleton
10. Agrometeorology: Principles and Applications of Climate Studies in Agriculture by: Harpal S., Ph.D. Mavi, Graeme J. Tupper
11. Developing Bioinformatics Computer Skills by: Cynthia Gibas
13. Bioinformatics: Sequence and Genome Analysis (Genome Analysis) by: David W. Mount
15. An Introduction to Bioinformatics Algorithms (Computational Molecular Biology)by: Neil C. Jones Pavel A. Pevzner
16. Bioinformatics: From Genomes to Drugs by: Thomas Lengaue
17. Essential Bioinformatics by: Jin Xiong
EC 201: Bioinformatics

Total Number of Hours: 60    Total Number of Credit: 02

Practicals:

1. A visit to Protein Data Bank, Ex Pasy, NCBI.
2. Study of Protein structures by Rasmol, Protein Explorer, Deep View.
3. Sequence alignment using FASTA and BLSAT.
4. LOCAL and GLOBAL alignment Tools.
5. Protein structure alignment.
6. PCR Primer designing.
7. Phylogenetic Tree Construction.
8. Use of Ex PASy Tools.
9. Active Site Prediction.
10. ORF Prediction.
NEW SYLLABUS: EFFECTIVE FROM JUNE 2017  
DEPARTMENT OF MICROBIOLOGY  
GUJARAT VIDYAPITH: SADRA  
MIC 301: BIOPROCESS TECHNOLOGY  
THEORY: 60 Hrs. CREDIT: 04: MARKS: 100 (EXTERNAL:60 & INTERNAL: 40)

Learning outcomes:
1. Student will understand the fundamentals of Bioprocess and Bioengineering.
2. Student will understand various steps of upstream and downstream processing.
3. Student will understand the design and control of Bioprocess Technology.

<table>
<thead>
<tr>
<th>Unit</th>
<th>Topic and Content</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit 1</td>
<td>Elements of Bioprocess</td>
<td>15 Hrs</td>
</tr>
<tr>
<td></td>
<td>❖ Isolation, screening and preservation of industrially</td>
<td></td>
</tr>
<tr>
<td></td>
<td>important microorganisms</td>
<td></td>
</tr>
<tr>
<td></td>
<td>❖ Strain improvement: isolation of mutant producing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>primary and secondary metabolites, isolation of</td>
<td></td>
</tr>
<tr>
<td></td>
<td>auxotrophic, resistant and revertant mutants and use</td>
<td></td>
</tr>
<tr>
<td></td>
<td>of recombination systems</td>
<td></td>
</tr>
<tr>
<td></td>
<td>❖ Media formulation, energy sources, antifoams and</td>
<td></td>
</tr>
<tr>
<td></td>
<td>media optimization</td>
<td></td>
</tr>
<tr>
<td>Unit 2</td>
<td>Fermenter Design and control</td>
<td>15 Hrs</td>
</tr>
<tr>
<td></td>
<td>❖ Fermenter design, types of fermenters</td>
<td></td>
</tr>
<tr>
<td></td>
<td>❖ The achievement and maintenance of aseptic</td>
<td></td>
</tr>
<tr>
<td></td>
<td>conditions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>❖ Monitoring and control of process variables</td>
<td></td>
</tr>
<tr>
<td></td>
<td>❖ Aeration-agitation system</td>
<td></td>
</tr>
<tr>
<td>Unit 3</td>
<td>Upstream processing</td>
<td>15 Hrs</td>
</tr>
<tr>
<td></td>
<td>❖ Sterilization of media, air and reactor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>❖ Development of inoculum for industrial fermentations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>❖ Mass transfer of oxygen-factors affecting KLa</td>
<td></td>
</tr>
<tr>
<td></td>
<td>❖ Fluid Rheology</td>
<td></td>
</tr>
<tr>
<td></td>
<td>❖ Fundamentals of scale up and Scale down</td>
<td></td>
</tr>
<tr>
<td>Unit 4</td>
<td>Downstream processing and Fermentation economics</td>
<td>15 Hrs</td>
</tr>
<tr>
<td></td>
<td>❖ Methods of cell separation- filtration and</td>
<td></td>
</tr>
<tr>
<td></td>
<td>centrifugation, Cell disruption, liquid-liquid</td>
<td></td>
</tr>
<tr>
<td></td>
<td>extraction, chromatography, membrane processes,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Drying, Crystallization, Whole broth Processing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>❖ Fermentation economics: Expenses for industrial</td>
<td></td>
</tr>
<tr>
<td></td>
<td>organisms, strain improvement, media sterilization,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>heating, cooling, aeration, agitation etc., cost of</td>
<td></td>
</tr>
<tr>
<td></td>
<td>plant</td>
<td></td>
</tr>
</tbody>
</table>
and equipment, batch process cycle time, continuous culture, recovery and effluent treatments, cost recovery due to waste usages and recycling

MIC 301: BIOPROCESS TECHNOLOGY
PRACTICAL: 90 Hrs. CREDIT: 03: MARKS: 100 (EXTERNAL:60 & INTERNAL: 40)

PRACTICALS

1. Determination of oxygen transfer rate (OTR-Sulfite method)
2. Isolation, screening and optimization of conditions for production of Amylase
   By Submerged fermentation
3. Primary Screening of Antibiotic Producer, Organic Acid Producer, Enzyme Producer,
4. Rheological study of culture broth by Oswald viscometer
5. Recovery of Exopolysaccharides using acetone solvent
6. Bio assay of Penicillin

References: MIC 301 Bioprocess Technology

1. Principles of Fermentation Technology: Stanbury, Whittaker & Hall
2. Process Biotechnology Fundamentals: S. N. Mukhopadhyay
3. Fermentation Microbiology and Biotechnology: EL-Mansi & C.F.A. Bryce eds
4. Industrial Microbiology by L E Casida.
Learning outcomes:-
1. Student will understand the characterization of wastes.
2. Student will understand the treatment of wastes.
3. Student will know geology and geological techniques.

<table>
<thead>
<tr>
<th>Unit</th>
<th>Topic and Content</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Principles of Waste Treatment</td>
<td>15 Hrs</td>
</tr>
<tr>
<td>1</td>
<td>1. Issues and scopes of environmental biotechnology.</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>4. Biochemistry and Microbiology of inorganic phosphorus and nitrogen removal.</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>5. Suspended growth technologies: Activated sludge, oxidation ditches, waste stabilization ponds.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Techniques of Waste Treatment</td>
<td>15 Hrs</td>
</tr>
<tr>
<td>2</td>
<td>1. Toxicity testing in waste water treatment plants using microorganisms.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2. Anaerobic digestion: microbiological and biochemical fundamentals, factors influencing anaerobic digestion.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Biodegradation and Deterioration</td>
<td>15 Hrs</td>
</tr>
<tr>
<td>3</td>
<td>2. Pollution problems and biodegradation of simple aliphatic, aromatic, polycyclic aromatic hydrocarbons, halogenated hydrocarbons, azo dyes, lignin and pesticides.</td>
<td></td>
</tr>
</tbody>
</table>
4 | **Biogeotechnology** | 15 Hrs
---|---|---
1. Bioleaching of metals: Characteristics of commercially important microbes, mechanisms of bioleaching, factors affecting bioleaching and current biomining processes.
2. Biobeneficiation of gold ores. Microbially enhanced oil recovery.

**References:**

1. Biotechnology-Rehm and Reid.
2. Waste water microbiology by G. Bitton
3. Biodegradation and bioremediation by M. Alexander
5. Environmental Biotechnology by H. Jordingen and Josef Winter.
6. Comprehensive Biotechnology Vol-4, Murray Moo Young.
NEW SYLLABUS: EFFECTIVE FROM JUNE 2017
DEPARTMENT OF MICROBIOLOGY
GUJARAT VIDYAPITH: SADRA
MIC- 303 “MICROBIAL TECHNOLOGY”
THEORY: 60 Hrs. CREDIT: 04: MARKS: 100 (EXTERNAL:60 & INTERNAL: 40)

Learning outcomes:-
1. Student will know preparation of various fermented food products.
2. Student will know preparation of various agricultural products.
3. Student will know preparation of various Industrial products.

<table>
<thead>
<tr>
<th>Unit</th>
<th>Topic and Content</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit-1</td>
<td><strong>Food Products</strong></td>
<td>15 Hrs</td>
</tr>
<tr>
<td></td>
<td>Food products from Grains- Bread</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Food products from Milk- Cheese, Butter</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Food products from Vegetables- Sauerkraut, Pickling</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Microbial cells as food- Single Cell Protein, Single Cell Oil</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Food safety and quality requirements- HACCP</td>
<td></td>
</tr>
<tr>
<td>Unit-2</td>
<td><strong>Agricultural Products</strong></td>
<td>15 Hrs</td>
</tr>
<tr>
<td></td>
<td>Biofertilizers- Production and application of rhizobium, azotobacter and azospirillum inoculants, Phosphate solubilizers, Phosphate mobilizers and absorbers- Mycorrhiza and VAM, composting</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Biocontrol agents- Bacterial and viral biopesticides, botanical pesticides, bioherbicides</td>
<td></td>
</tr>
<tr>
<td>Unit-3</td>
<td><strong>Industrial products- Primary and Secondary metabolites</strong></td>
<td>15 Hrs</td>
</tr>
<tr>
<td></td>
<td>Organic acids- Acetic acid, Citric acid</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Amino acids- L-Lysin, L-Glutamic acid</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vitamins- B12 and Ascorbic acid</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Enzymes- Protease, Amylase</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Antibiotics- Streptomycin, tetracycline</td>
<td></td>
</tr>
<tr>
<td>Unit-4</td>
<td><strong>Other Industrial Products</strong></td>
<td>15 Hrs</td>
</tr>
<tr>
<td></td>
<td>Ergot alkaloids</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Alcoholic beverages- Beer, Wine</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Polymers- Xanthan, Dextran</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Solvents- Acetone-butanol</td>
<td></td>
</tr>
</tbody>
</table>

MIC- 303 “MICROBIAL TECHNOLOGY”
THEORY: 90 Hrs. CREDIT: 03: MARKS: 100 (EXTERNAL:60 & INTERNAL: 40)

Practicals-
Laboratory fermentation and estimation of Single cell protein
Laboratory fermentation and estimation of alcohol
Laboratory fermentation and estimation of alcoholic beverages
Laboratory fermentation and estimation of citric acid
Laboratory fermentation and estimation of single cell oil
Laboratory fermentation of Bread
Laboratory fermentation and estimation of Exopolyssaccharides.
Laboratory fermentation and estimation of enzyme.
Determination of microbiological quality of milk by MBRT
Laboratory fermentation and estimation of dairy product.

**Reference Books**
Comprehensive Biotechnology: The Principles, Applications and Regulations of Biotechnology in Industry, Agriculture and Medicine, Vol. 1 to 4, Editor in chief- Murray, Moo-young, Pergamon Press, Oxford
Industrial Microbiology- Prescott, SC and Dunn, CG, Agrobios Publication, Jodhpur
Biotechnology- Rehm HJ and Reed, G, VCH Publication
Biofertilizers in Agriculture and Forestry- Subba Rao, NS
Biological Nitrogen Fixation- SUbba Rao, NS, Venkataraman, GS and Kannaiyan S
*Bacillus thuringiensis* as a Biocontrol agent- Kadu, BB
Biotechnology of Industrial Antibiotics- Vandamme, EJ
NEW SYLLABUS: EFFECTIVE FROM JUNE 2017
DEPARTMENT OF MICROBIOLOGY
GUJARAT VIDYAPITH: SADRA
EC 301: BIOMETHANATION
THEORY: 60 Hrs. CREDIT: 04: MARKS: 100 (EXTERNAL:60 & INTERNAL: 40)

Learning outcomes:
1. Student will understand principles and processes of anaerobic digestion.
2. Student will understand the role of various trophic groups in anaerobic conditions.
3. Student will understand the principles and working of various anaerobic digesters.

<table>
<thead>
<tr>
<th>Unit</th>
<th>Topic and Content</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit 1</td>
<td>Historical overview</td>
<td>15 Hrs</td>
</tr>
<tr>
<td></td>
<td>❖ Historical overview, Modern Era, 1950, 1960, Microbial Basis, Methyl Cobalamine era, Serine Era, Esolution of methanobacillus omilanskii, 1970 to present.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>❖ Diversity of Methanogens, Classification of Methanogens, Taxa of methanogens, Methanobacteriales, Methanococcales, Methanomicrobiales, Methaosarcinales, Methanopyrales</td>
<td></td>
</tr>
<tr>
<td>Unit 2</td>
<td>Physiology of Methaogens: Substrate range of Methanogens</td>
<td>15 Hrs</td>
</tr>
<tr>
<td></td>
<td>❖ Physiological Adaptations ( Salinity, temperature, pH, Oxygen, Genetic and Metabolic Regulations, Motility and Gas vesicles reserve materials)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>❖ Microbial Interactions: Competition for methanogenic substrates: General considerations, Competition for hydrogen, Competition for acetate, Competition for other methanogenic Substrates, Facultative Interspecies H₂ formate transfer, Obligate Interspecies H₂ formate transfer, Interspecies acetate transfer.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>❖ Methods to study Methanogens in Natural Habitats: Cultural Methods, Microscopic, immunological, Molecular Biology, Activity measurement, Stable isotopes.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>❖ Methanogenic Habitats: Anaerobic Digesters, Fresh water sediments and soils, marine habitats, Animal GIT, Geothermal habitats, Other habitats</td>
<td></td>
</tr>
<tr>
<td></td>
<td>❖ Biotechnological Uses of Mixed Methanogenic Cultures: Novel Substrates and Anaerobic bioreactor Configurations, Thermophilic Anaerobic Digestion, Anaerobic dehalogination.</td>
<td></td>
</tr>
<tr>
<td>Unit 3</td>
<td>Biochemistry of Methanogenesis:</td>
<td>15 Hrs</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Unit 4</th>
<th>Biosynthesis of Co-enzymes</th>
<th>15 Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Methanofuran, Tertahydromethanopterin, HSHTP, COM</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Anabolic pathways: Central Anabolic pathways (Acetyl CoA, Pyruvate, Incomplete TCA cycle), Precursor Biosynthesis, Carbohydrate biosynthesis</td>
<td></td>
</tr>
</tbody>
</table>

**References:** EC 301: BIOMETHANATION

**Methanogenesis:** Ecology, Physiology, Biochemistry & Genetics. James G. Ferry.
NEW SYLLABUS: EFFECTIVE FROM JUNE 2017
DEPARTMENT OF MICROBIOLOGY
GUJARAT VIDYAPITH: SADRA
MIC 401: BIOSTATISTICS AND COMPUTER APPLICATIONS
THEORY: 60 Hrs. CREDIT: 04: MARKS: 100 (EXTERNAL:60 & INTERNAL: 40)

Learning outcomes:-
1. Students will learn to use various statistical measures for data analysis.
2. Students will learn to find out significance of experimental data.
3. Students will learn basics of computers useful for data analysis.

<table>
<thead>
<tr>
<th>Unit</th>
<th>Topic and Content</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unit-I Basics of statistics</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Introduction to Statistics; Collection, classification and tabulation of data Frequency distribution</td>
<td>15 Hrs</td>
</tr>
<tr>
<td></td>
<td>Unit-II Statistical measures</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Measures of location- Arithmetic mean, median and mode Measures of dispersion- Range, standard deviation, coefficient of variation, skewness, kurtosis</td>
<td>15 Hrs</td>
</tr>
<tr>
<td></td>
<td>Unit-III Statistical analytical techniques</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Tests of hypotheses Correlation and Regression Probability - normal, poison and binomial Time series analysis.</td>
<td>15 Hrs</td>
</tr>
<tr>
<td></td>
<td>Unit-IV Bioinformatics and computers</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Bioinformatics and its applications Computer- classification, functional blocks of computer hardware, input &amp; output devices, application of computers</td>
<td>15 Hrs</td>
</tr>
</tbody>
</table>

References and suggested readings:
3. Textbook of Computer applications and biostatistics- ebook, Dr. S. B. Bhise, Dr. R. J. Dias, K. K. Mali and P. H. Ghanwat, Trinity publishing house, Satara
4. Modeling Tools for Environmental Engineers and Scientists, by N. Nirmala Khandan, CRC PRESS
NEW SYLLABUS: EFFECTIVE FROM JUNE 2017
DEPARTMENT OF MICROBIOLOGY
GUJARAT VIDYAPITH: SADRA
MIC 402: RESEARCH METHODOLOGY AND SCIENTIFIC WRITING
THEORY: 60 Hrs. CREDIT: 04: MARKS: 100 (EXTERNAL:60 & INTERNAL: 40)

Objectives:

- To verify and test important facts
- To analyse an event or process or phenomenon to identify the cause and effect relationship
- To develop new scientific tools, concepts and theories to solve and understand scientific problems.
- To find solutions to scientific.
- To overcome or solve the problems occurring in our everyday life.
- To introduce the concept of scientific research and the methods of conducting scientific enquiry.

<table>
<thead>
<tr>
<th>Unit</th>
<th>Topic and Content</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Research Methodology</strong></td>
<td>15 Hrs</td>
</tr>
<tr>
<td>1</td>
<td>1. Research methodology: An Introduction: Creativity, innovation, originality and advancement of knowledge and application to the society</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Define the research problem</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Methods of Research</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Ethics in research</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Research Design</strong></td>
<td>15 Hrs</td>
</tr>
<tr>
<td>2</td>
<td>1. Meaning and Objectives,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Characteristics of good research design.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Components of the research design.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Review of literature.</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Research Project and Research Proposals</strong></td>
<td>15 Hrs</td>
</tr>
<tr>
<td>3</td>
<td>1. Selecting a Research Topic.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Project Planning.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Identifying funding sources and special founding mechanisms.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Writing a Proposal.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5. Research Ethics and Responsibilities.</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Scientific Writing (From Research to Manuscript)</strong></td>
<td>15 Hrs</td>
</tr>
<tr>
<td>4</td>
<td>1. Tools and Techniques.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. The Scientific Paper.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Scientific writing skills.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Preparing to Publish.</td>
<td></td>
</tr>
</tbody>
</table>
References: MIC 402: RESEARCH METHODOLOGY AND SCIENTIFIC WRITING


SEMESTER 4 MIC 403: Project / Dissertation Work Theory
The candidate is required to show article to faculty in/before interpreting his/her experimental work.
Two typed/computerised bound copies of the dissertation shall be submitted to the University during the final M.Sc. at least fifteen days before the commencement of the final examination.

MIC 402: Seminar / Field Work / Study Tour
Atleast two seminars should be delivered during fourth semester.
There shall be one microbiological study tour / field work during fourth or any semester of P.G. study. It will pertain to different microbiological / environmental industries / research institute / various ecosystems even outside Gujarat State. The microbiological tour is highly essential for studying microbiological process and technology.

MIC 403: Assignments, Group Discussion / Industrial Training
Assignments and group discussions / industrial training accomplished with the bound copy of report are necessary for evaluation.